

First record of campodeids (Diplura: Campodeidae) from caves in Australia

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Abstract – Nine specimens of Campodeidae, collected from six caves in northern and northwestern Australia, all belonging to the same species, *Cocytocampa humphreysi* sp. nov., are described. The caves, located at Cape Range and Kimberley, Western Australia, and Katherine, Northern Territory, are separated by more than 2000 kilometres across an extremely arid region. The samples included at least two populations, separated on the basis of the number of microchaetae on urosternites II to VII, but the low number of specimens does not allow an accurate statistical treatment.

INTRODUCTION

Two species of cave-adapted Campodeidae are known from the Australian region: *Leletocampa marthaleri* Condé, 1982 from New Ireland (Lamerigamas Cave, Lelet Plateau, 1260 m) and *Lepidocampa* (s. str.) *chapmani* Condé, 1989 from Papua New Guinea (Okemimal Tem Cave, Finin Tel Plateau, Western Province, rain forest, 2300–2400 m). *Leletocampa marthaleri* exhibits several characters in common with other troglobiontic species (numerous sensilla – 10 here – in the cupuliform organ of the apical article of the antenna; elongate legs; claws unequal with laterotergal crests); in *Lepidocampa chapmani* only the cupuliform organ with 13 to 17 sensilla and length of cerci (unknown in *Leletocampa*) are diagnostic of a true cavernicolous species. In addition endogean representatives of the *Lepidocampa weberi* Oudemans complex are known from caves in Papua New Guinea, New Britain and New Ireland (Condé 1982, 1989).

Campodea (*Indocampa*) *novaecaledoniae* Condé, 1980 was described from a cave in New Caledonia (grotte de Ouauoué, types), but specimens from two other caves (grottes d'Adio and de Koumac) and several endogean locations were provisionally referred to that species.

The new species here described has the appearance of an endogean species, with cupuliform organ housing but four sensilla; nevertheless it may be a cave-dwelling species "in status nascendi", similar to some European species which have never been found outside a cave although they have none of the morphological criteria usually associated with the hypogean biotopes.

Seven specimens of the new species, referred to

the genus *Cocytocampa*, were obtained from the Western Australian Museum (WAM), Perth, through the courtesy of Dr W.F. Humphreys, Senior Curator, Department of Terrestrial Invertebrate Zoology. These specimens comprise the total collection of campodeids made over several years from numerous visits to Cape Range and two months field work in the Kimberley and a single collection in the Northern Territory. Two further specimens from a cave in the Northern Territory were sent by the Museums and Art Galleries of the Northern Territory, Darwin, through the courtesy of Dr G.R. Brown, Curator of Entomology. Specimens were mounted in Marc André II medium and deposited in the following institutions: Western Australian Museum (WAM-BES numbers are field codes) and the Northern Territory Museum of Arts and Sciences (KAB). Morphological methods and terminology follow Condé (1956, 1982).

SYSTEMATICS

Order Diplura Börner, 1904

Family Campodeidae Westwood, 1874

Cocytocampa Paclt, 1957

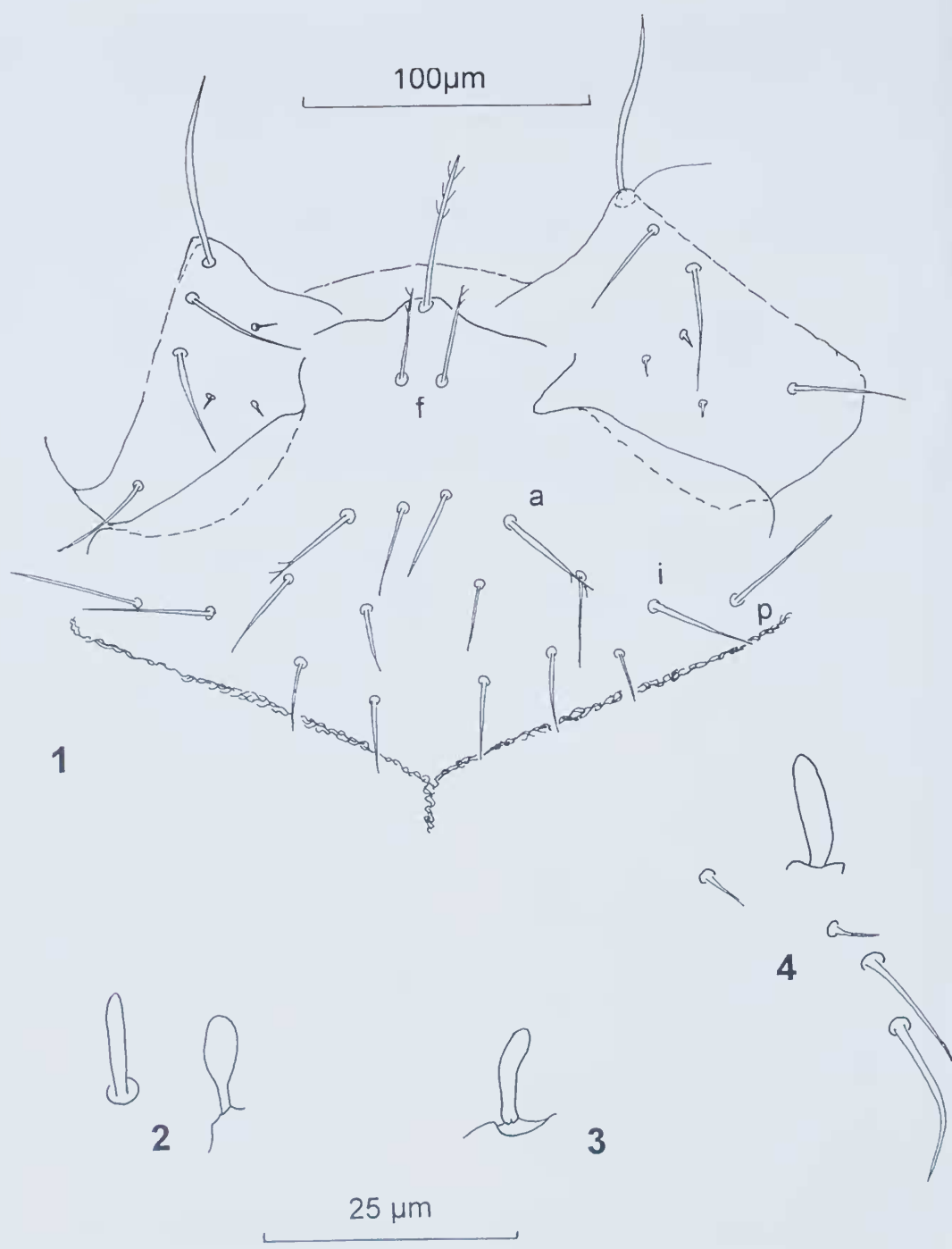
Cocytocampa humphreysi sp. nov.

Figures 1–4, 8–12

Material Examined

Holotype

Australia: Western Australia: ovigerous female, Cape Range, C-111, 21°55'S, 114°00'E, 10 May 1995, B. Vine, WAM 1998/0153, BES 4113.



Figures 1-4 *Cocylocampa humphreysi* sp. nov., holotype BES 4113. 1, Head, anterior part with frontal process (f) and the macrochaetae along the line of insertion of the antenna (a, i, p); 2, Sensillum of the third antennal article (left) and the same in *Cocylocampa catalae*, holotype female (right); 3, Sensillum of the maxillary palp; 4, Sensillum of the labial palp with the two accessory short setae. Figure 1. Scales: figure 1 = 100 µm, figures 2-4 = 25 µm.

Table 1 Measurements of specimens of *Cocytocampa humphreysi* sp. nov.

Characters (lengths in mm)	Cape Range			Kimberley and Northern Territory populations (?subspecies)					
	Holotype	Paratype	Paratype	BES	BES	BES	BES	KAB	KAB
	BES 4113 ff	BES 4210 ff	BES 680 ff	2707 ff	3217 mm	3217 ff	3217 l.	92-14 ff	92-14 ff
Body length	3.88	2.76	2.20	3	2.40	2.60	1.26	2.31	2.51
Leg II length*	0.64	0.47	0.40	0.39	0.40	0.49	0.26	–	0.47
Leg III length*	0.89	0.63	0.51	0.50	0.55	0.66	0.35	0.69	0.64
Microch. II–VII	57	45	52	21	?	16	12	21	16
Antennal art.	30	22/22	–	25	–	–	–	–	27/27
Cercus length	–	1.48	–	–	–	–	–	1.94	–

*Femur+tibia+tarsus

Paratypes

Australia: Western Australia: 1 ovigerous female, Cape Range, C-215, 22°02'S, 113°56'E, 19 May 1995, B. Vine, WAM 1998/0154, BES 4210; 1 female, Cape Range, C-65, 22°06'S, 114°00'E, 18 August 1992, W.F. Humphreys, R.D. Brooks, WAM 1998/0155, BES 680.

Other Material Examined

Australia: Western Australia: 1 ovigerous female, Kimberley, KJ-8, 15°26'S, 128°44'E, R.D. Brooks, WAM 1998/0156, BES 2707. Northern Territory: 1 male, 1 ovigerous female, 1 larva, Cutta Cutta Cave (8 K1), NE of Katherine, 14°35'S, 132°25'E: 25 June 1994, W. Binks. WAM 1998/0157-0159, BES 3217; 2 females, Cave North of Katherine and Cutta Cutta Cave, 15 May 1993, P. Bannink, KAB 92:14.

Diagnosis

Notal macrochaetae of thorax long and slender, shared with *C. catalae* Condé, 1980; antennae with 22–30 articles, *vs* 16–20 in other species of the genus; small groups of microchaetae external to

posteriomedial pair of macrochaetae on urosternites II–VII (total number: 45–57 in Cape Range, 12–21 in Kimberley and Northern Territory).

Description (Figures 1–4 and 8–12)

Tegument: Epicuticula without ornaments. Clothing setae slender and smooth.

Head: Antennae (Table 2) with 22–30 articles (16–20 in congeneric species), apical article with 4 sensilla in the cupuliform organ. Bacilliform sensillum of third article slender, finger-like; between *d* and *e* (sternal position); the sensilla of maxillary and labial palps slightly claviform, all about 10 µm long. Labial palp with 10–12 short setae along the anterior border and more than 80 neuro-glandular (gustative) setae on the posterior surface.

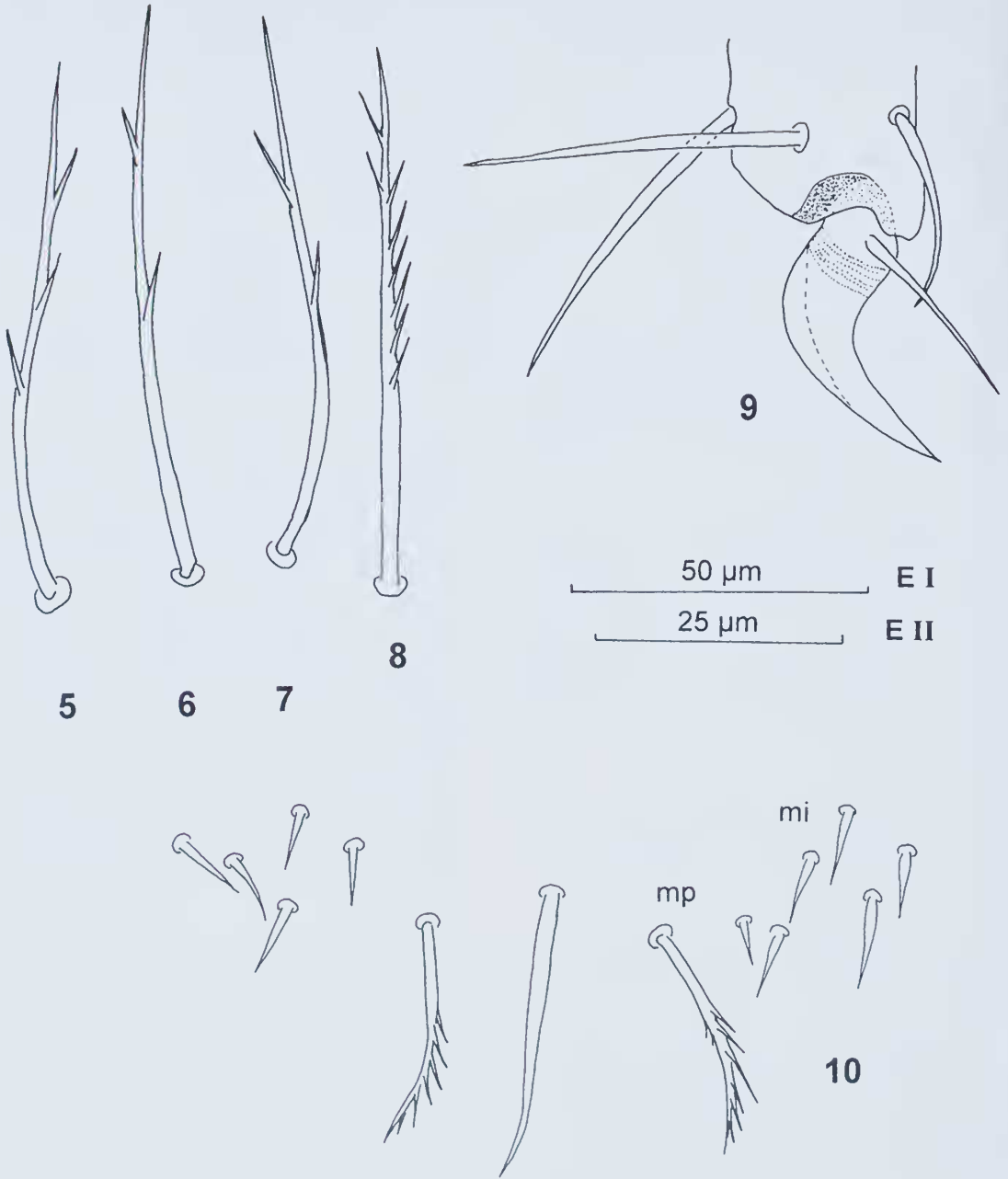
Frontal process (= rostrum) with three macrochaetae, the anterior 1.46 times length of posterior pair, the apex of anterior macrochaeta more barbed. 3+3 macrochaetae, *i*, *p*, relative lengths respectively 20, 23, 24, along the line of insertion of the antennae: *a* with two subapical barbs.

Table 2 Frequency distribution of the number of antennal articles recorded in *Cocytocampa* species.

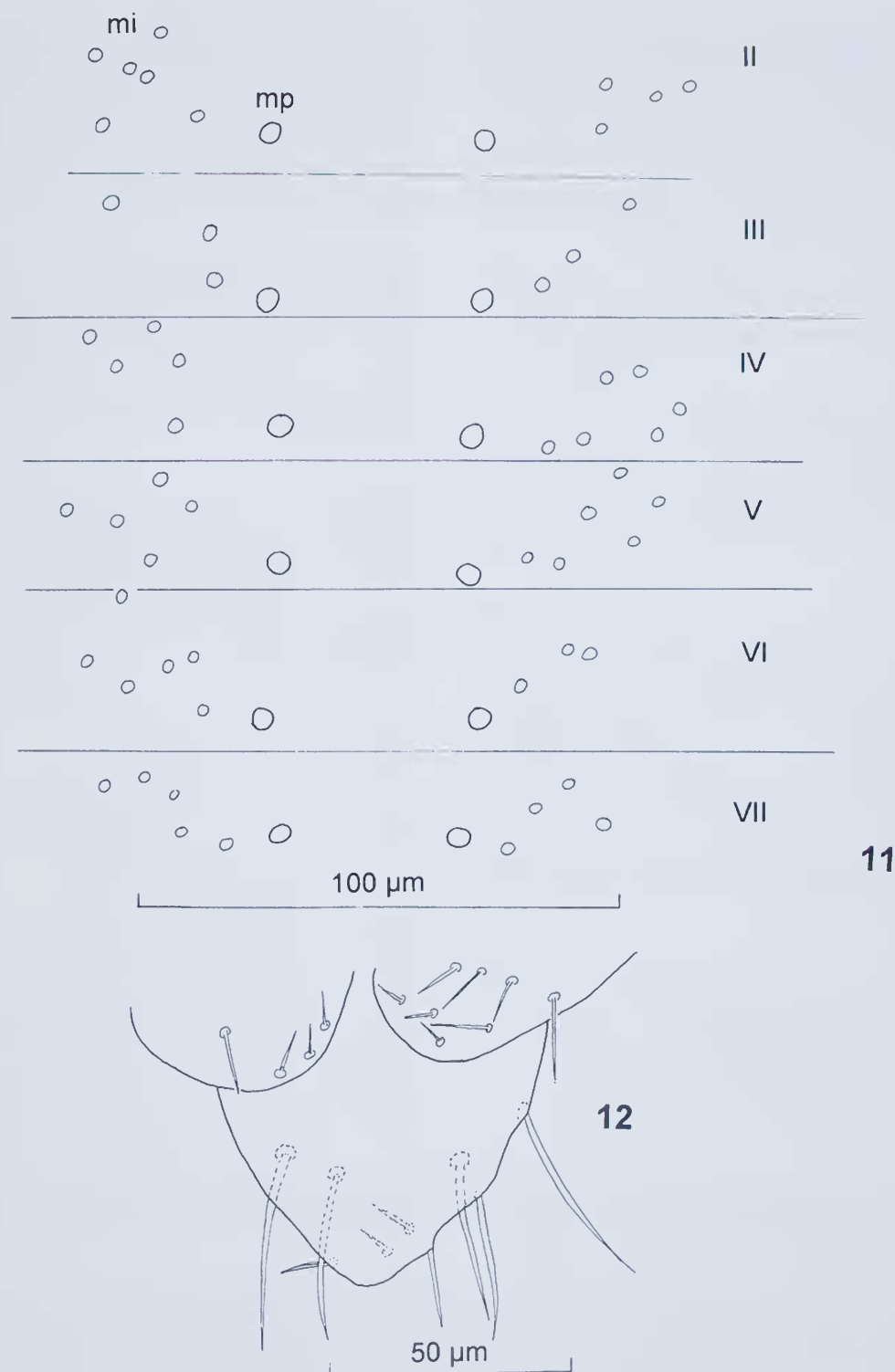
Species	Location	16	17	18	Frequency		25	27	30
					20	22			
<i>C. perkinsi</i> (type species)	Hawai'i	3	–	–	–	–	–	–	–
<i>C. solomonis</i>	Solomon Is.	8	241	179	1	–	–	–	–
<i>C. solomonis</i>	New Ireland	2	–	–	–	–	–	–	–
<i>C. s. borneensis</i>	Borneo	–	–	5	–	–	–	–	–
<i>C. catalae</i>	New Caledonia	–	–	–	2	–	–	–	–
<i>C. humphreysi</i>	NW Australia	–	–	–	–	2	1	2	1

Table 3 Averages and ranges (in brackets) for measurement ratios in *Cocytocampa humphreysi* sp. nov. from Cape Range. Ratio definitions follow Denis (1932). Holotype in bold. Macrochaetae are: *ma* = anteromedial, *la* = anterolateral, *lp* = posterolateral; *lp*/*M* is the ratio of length of *lp* to the mean length of the marginal setae.

	<i>ma</i> / <i>la</i>	<i>lp</i> / <i>ma</i>	<i>lp</i> / <i>M</i>	<i>lp</i> II/ <i>lp</i> III
Th. I	1.29 (1.13–1.24–1.50)	1.84 (1.59–1.84–2.10)	2.32 (2.27–2.38)	–
Th. II	0.85 (0.81–0.89)	1.71 (1.57–1.69–1.88)	2.18 (2.05–2.32)	–
Th. III	–	1.76 (1.63–1.70–1.96)	2.01 (1.96–2.07)	1.05 (1.01–1.11)



Figures 5-7 *Cocytocampa catalae* Condé, holotype female. Posterolateral macrochaetae of thoracic tergites I, II, III. Figures 8-10. *Cocytocampa humphreysi* sp. nov., paratype female BES 4210; 8, Posterolateral macrochaeta of the thoracic tergite II; 9, Telotarsus and claw of right leg II, anterior view. Holotype female BES 4113; 10, Posteromedial part of urosternite V with microchaetae (*mi*) and Posteromedial macrochaetae (*mp*). Figures 5-8 and 10 scale = E_I ; 9 = E_{II} .



Figures 11–12 *Cocytocampa humphreysi* sp. nov., holotype female BES 4113; 11, Urosternites II–VII, diagrammatic: *mi* = microchaetae; *mp* = macrochaeta posteriomedial; 12, Genital papilla: lateral genital valves with three short and five longer setae.

Thorax: Macrochaetae long, slender, with numerous short barbs which are distinct on the distal half. Relative lengths for the Cape Range specimens are shown in Table 3.

Tibia with one barbed ventral macrochaeta; tibial spurs with several rows of barbs. Claws subequal, angular, latero-tergal crests very reduced, transverse scratches near the base; telotarsal process setiform, slender, a little shorter than claws or subequal.

Abdomen: Urotergites I to VII without macrochaetae. 2+2 *lp* on VIII and 4+4 on IX, similar to the thoracic *lp* but a little shorter ($\times 0.92\text{--}0.95$). Supra-anal valvule with one smooth subapical seta.

Urosternite I with 5+5 macrochaetae (*mp* missing). Lateral appendages of the holotype (female) subcylindrical ($L/l = 1.77$) with about 20 glandular setae *a1*. On the only male available (WAM 1998/0157 [BES 3217], non-paratype) viewed laterally: appendages cylindrical; four rows of glandular setae *g1* along the posterior margin, two rows of short and slender ordinary setae in front of the glandular ones.

Urosternites II–VII with 4+4 well differentiated microchaetae and two groups of very short setae, more or less conical, near the posterior border external to the medial pair of macrochaetae (*mp*). The number of microchaetae is apparently related to size (=age?) and to the population (? subspecies). The mean number of microchaetae (range) are: Cape Range 51.3 (45–57); Kimberley and Northern Territory, 18.8 (16–22) (Table 4).

Apical seta of styli with two proximal short denticles and a few longer and slender barbs (4–5) medially; subapical seta with numerous barbs regularly along the stem; medial ventral seta with long barbs on the distal half.

Urosternite VIII with 1+1 macrochaetae. Lateral genital valves of female (holotype) with 8 setae each (3 short and 5 longer); medial tubercle with 2+3 dorsal and lateral strong setae and 2+2 dorsal and apical short and thin setae.

Two cerci only present in the material. Female BES 4210 (paratype). Ratio body/cercus (mm)

2.76/1.48 = 1.87. Base (clearly divided into five subequal secondary articles) and eight primary articles. Respective lengths: 161–39+40+44+46+50+54+49+64. Female KAB 92–14 (non-paratype). Ratio body/cercus (mm) 2.31/1.94 = 1.19. Base (divided into four secondary articles) and ten primary articles. Respective lengths: 155–40+41+45+51+61+58+70+85+80+80.

Variation

The macrochaetae of the cerci are a little shorter in the Cape Range specimens than in those from the Northern Territory ($\times 0.80\text{--}0.91$), and the barbed section is a little shorter than the smooth one in Cape Range ($\times 0.86\text{--}0.93$) and the reverse in Northern Territory ($\times 1.24\text{--}1.70$). The barbs are short and thin.

Etymology

The new species is named in honour of Dr W.F. Humphreys, Senior Curator, Department of Terrestrial Invertebrate Zoology, Western Australian Museum, who collected or gathered the material, sent it for study and provided information about the biotopes and the biogeography of the local fauna.

DISCUSSION

Microcampa, a monotypic subgenus of *Plusiocampa*, was established by Silvestri (1934: 519) for the small (1.80 mm TL) endogean species he described from Hawai'i (Oahu), *Plusiocampa (Microcampa) perkinsi*. Ascertaining that *Microcampa* Silvestri, 1934 is preoccupied by *Microcampa* Kawada, 1930 (Lepidoptera), Paclt (1957: 27) introduced *Cocytocampa* nom. nov. as a subgenus of *Litocampa* Silvestri (1933: 117) which was erected at the same time to generic rank. According to Paclt, the subgenus *Cocytocampa* includes eight species from France (2), France and Switzerland (2), Mexico (1), Brazil (1), French Guinea (1) and Hawai'i (1).

At the revision of the cotype of *perkinsi*,

Table 4 Body length (LT mm) and counts of the microchaetae on urosternites II–VII of *Cocytocampa humphreysi* sp. nov. in Cape Range specimens (type specimens) and in those from the Kimberley and Northern Territory (? subspecies). L= larva.

		LT	II	III	IV	V	VI	VII	Total
BES 4113 ♀ holotype	Cape Range	3.88	5+6	3+3	6+5	6+5	3+6	4+5	57
BES 4210 ♀ paratype	Cape Range	2.76	2+2	3+4	4+4	5+5	4+4	4+4	45
BES 680 ♀ paratype	Cape Range	2.20	6+5	4+5	5+3?	5+5	4+5	3+2?	52
BES 2707 ♀	Kimberley	3.10	3+2	2+2	2+2	2+2	3+2	0	21
BES 3217 ♀	Northern Territory	2.60	2+2	2+2	1?+2	1+1	1+?	1+1	16
BES 3217 L	Northern Territory	1.26	1+1	1+1	1+1	1+1	1+1	1+1	12
KAB 92–14 ♀	Northern Territory	2.31	2+2	2+2	2+2	2+2	1+2	1+1	21
KAB 92–14 ♂	Northern Territory	2.51	2+1	2+2	2+1	1+1	1+1	1+1	16

preserved in the Bernice P. Bishop Museum, Honolulu (cotype 3747) – prescribed by the description of a new species from the Solomon Islands – Bareth and Condé (1972: 238) accepted Paclt's changes: *Litocampa* (*Cocytocampa*) *solomonis*; they emphasised however (loc. cit.: 237) the ambiguous diagnosis of *Litocampa* and the heterogeneity of the eight species included in the subgenus *Cocytocampa*, and stressed the similarity of *perkinsi* and *solomonis* with *Indocampa* Silvestri, 1933 a subgenus of *Campodea* from the Indian, Madagascan and Australian regions. When *Cocytocampa solomonis* was recorded from New Ireland, Condé (1982: 720–741) separated *Cocytocampa* from *Litocampa*.

Cocytocampa humphreysi is distinct from *C. catalae* Condé, 1980 (subgen. *Litocampa*), an endogean species from New Caledonia (Mont Mou, 25–30 km NNW of Nouméa, 1220 m beneath stone), by the 1p macrochaetae of the thoracic tergites with numerous short barbs (vs 2–3 long ones), the shape of the sensillum on the third antennal article (digitiform vs claviform) and the microchaetae on the urosternites II–VII (vs missing). These small setae were discovered in *C. solomonis* where they take up the medial region in two groups: the anterior group being less numerous than the posterior group which is located between the *mp*. The number of microchaetae increases during post embryonic growth and are variable between islands in the Solomons, being more numerous in females than in males (62–51 vs 43–26). The two females from New Ireland have 67 and 72 microchaetae. Microchaetae are absent from the other species of *Cocytocampa* but present in *Campodea* (*Indocampa*) *intermedia* Condé, 1990 from Sabah, which has 26 setae (1+1 to 3+2 on each sternite) in the juvenile female and 12 in the larva (1+1 to 2+2 on one sternite). Similar microchaetae, but less numerous and external to *mp*, were recorded for *Campodea* (*Indocampa*) *sutteri* Condé, 1953, from Sumba and *C. (I.) deharvengi* Condé, 1982, from Papua New Guinea; in the latter species, the total number of setae is 21 for the female paratype, 13 for the male holotype and juvenile females, and 12 for the larvae. Lastly, they were also noted in the monotypic genus *Papucampa* Condé, 1982, from Papua New Guinea, the holotype male having 19 (1/3 to 2/3 on the middle of one sternite).

According to W.F. Humphreys (*in litt.* 30.10.95) "it is somewhat surprising that the species seems to be widespread given the differences in other groups" and, recently (7 July 1997) "... it is unlikely that endogean species will be found in the area. This is the case with many groups which, while not overtly troglomorphic, seem to have survived in the area because of the karst habitat".

It is possible that isolation is reflected in the

number of microchaetae (45–57 vs 16–22) and the articles of the antennae (27–30 vs 22–25) but the number of specimens available does not allow any statistical treatment.

The five known species of *Cocytocampa* are restricted to the central and western Pacific Hawai'i (*perkinsi*), Solomon Islands and New Ireland (*solomonis*), New Caledonia and Australia (*catalae*, *humphreysi*), Borneo (*s. borneensis* in Condé 1990) and Thailand (*entrichoides* in Condé 1994). The discovery of *Cocytocampa* brings to five the number of genera recorded from Australia, after *Campodea*, *Campodella*, *Metriocampa* and *Notocampa* (Houston 1994).

The Campodeidae from Australia are in need of global revision, using type material, if available and in good condition, or at least topotypes. Most of the descriptions are old with few illustrations and many important characters are unknown. A lot of work is necessary before a satisfactory knowledge of the Australian Campodeidae can be achieved.

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REFERENCES

- Bareth, C. and Condé, B. (1972). Diploures Campodéidés des îles Salomon. *Revue d'Ecologie et de Biologie du Sol* 9: 235–256.
- Condé, B. (1953). Campodeidae (Entotrophi) de Sumba. *Verhandlungen der Naturforschenden Gesellschaft Basel* 64: 115–117.
- Condé, B. (1956). Matériaux pour une Monographie des Diploures Campodéidés. *Mémoires du Muséum national d'Histoire naturelle, Paris, A. Zoologie*, 12: 1–202.
- Condé, B. (1980). Diploures Campodéidés des grottes de Nouvelle-Calédonie. *Revue suisse de Zoologie* 87: 193–200.
- Condé, B. (1982). Diploures Campodéidés de Papouasie. *Revue suisse de Zoologie* 89: 731–748.
- Condé, B. (1989). Prodromes d'une Evolution souterraine dans le genre *Lepidocampa* Oudemans. *Mémoires de Biospéologie* 16: 153–156.
- Condé, B. (1990). Diploures Campodéidés de Bornéo. *Revue suisse de Zoologie* 97: 465–475.

- Condé, B. (1994). Nouveaux Campodéidés endogés de Thaïlande. *Revue suisse de Zoologie* **101**: 335–359.
- Denis, J.R. (1932). Campodés pyrénéens récoltés par H. Gadeau de Kerville. *Société entomologique de France, Livre du Centenaire*: 597–614.
- Houston, W.W.K. (1994). Diplura. Pp 139–156 in W.W.K. Houston (ed.), *Zoological Catalogue of Australia volume 22, Protura, Collembola, Diplura*. Melbourne: C.S.I.R.O. Australia xii: 188pp.
- Pact, J. (1957). Diplura in P. Wytsman *Genera Insectorum* 212E, Crainhem (Belgique), Ed. Mercurius, 44 Rodestraat, Anvers: 123 pp.
- Silvestri, F. (1933). Thysanura (Insecta). In: Spedizione del Prof. Nello Beccari nella Guiana britannica. *Bollettino del Laboratorio di Zoologia generale ed agraria del R. Istituto superiore agrario di Portici* **27**: 114–124.
- Silvestri, F. (1934). Description of a new species of Thysanura (Campodeidae) from the Hawaiian Islands. *Proceedings of the Hawaiian Entomological Society* **8**: 519–522.

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